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Stoneflies of the genus *Neoperla* (Plecoptera, Perlidae) from Wuyi Mountain National Nature Reserve, Fujian of China

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Abstract

The species of the genus *Neoperla* are reviewed from Wuyi Mountain National Nature Reserve located in the Fujian Province of southeastern China, including the description of a new species, *Neoperla brevistyla* **sp. n.** The new species is compared to similar taxa. The first records of five *Neoperla* species, *N. henana* Li, Wu & Zhang, 2011, *N. similiserecta* Wang & Li, 2012, *N. qingyuanensis* Yang & Yang, 1995, *N. xuansongae* Li & Li, 2013 and *N. tuberculata* Wu, 1938 are given for the Wuyi Mountain. A provisional key is provided for facilitating the identification of these species.

Keywords

Plecoptera, Perlidae, *Neoperla*, new species, China

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Introduction

The stonefly genus *Neoperla* is the most species-rich genus within the subfamily Perlinae (Sivec et al. 1988, DeWalt et al. 2013). There are over 70 known species in China described by Chu (1929), Du (1999, 2000a, 2000b), Du and Sivec (2004, 2005), Du and Wang (2005, 2007), Du et al. (1999, 2001), Sivec and Zwick (1987), Wu (1935, 1938, 1948, 1962, 1973), Wu and Claassen (1934), Yang and Yang (1990, 1991), Yang and Yang (1992, 1993, 1995a, 1995b, 1996, 1998), Li et al. (2011), Li et al. (2011), Li and Wang (2011), Li et al. (2012), Li et al. (2012), Li and Li (2013), Li et al. (2013a) and Li et al. (2013b).

In the present paper, the species of the genus *Neoperla* are reviewed from Wuyi Mountain National Nature Reserve, Fujian Province of China based on the fresh material collected in recent years. With a total area of ca. 565 km^2, the Reserve possesses a typical subtropical forest ecological system and is the largest area for biodiversity conservation in Fujian Province, south-east China (http://www.wbr.cn/).

Material and methods

Types and other examined material are deposited in the Insect Collection of Henan Institute of Science and Technology (HIST), Xinxiang, and the Entomological Museum of China Agricultural University (CAU), Beijing. They were examined with the aid of a Motic SMZ 168 microscope and the color illustrations were captured using digitalized software Motic Images Advanced 3.2. All specimens were kept in 75% ethanol. Aedeagi were everted using the cold maceration technique of Zwick (1983). Terminology follows that of Sivec et al. (1988).

Taxonomy

Neoperla breviscrotata Du, 1999

http://species-id.net/wiki/Neoperla_breviscrotata

Neoperla breviscrotata Du, 1999: 312. Type locality: Guizhou Province, Sandou, Chengguan.

Distribution. China (Guizhou, Anhui, Shandong, Fujian, Shaanxi).

Remarks. This species was recently described by Du (1999) from the localities listed above including the Wuyi Mountain, but no new material was available to the present study.

Neoperla brevistyla **Li & Murányi, sp. n.**
http://zoobank.org/6FB22544-4438-4E18-8E5C-4F68C9BB1498
http://species-id.net/wiki/Neoperla_brevistyla
Figs 1–2

Type material. 1 male (CAU), China: Fujian Province, Mt. Wuyishan, Sangang, 735 m, 27°74.78'N, 117°68.31'E, light trap, 12 Jul. 2009, Li Shi and Xiaoyan Liu. Paratypes: 2 males, the same data as holotype, (CAU); 6 males, the same locality, 16 Aug. 2006, Hui Dong, (HIST).

Male. Forewing length 15.6–16.0 mm. Distance between ocelli about as wide as diameter of the ocellus. Head slightly wider than pronotum, with an obscure quadrate dark stigma on frons and a brown area covering ocelli (Fig. 1a); compound eyes black and antennae dark; maxillary palpi brown. Pronotum with obscure rugosities and dark brown anterior and lateral margins, thorax mostly brown (Fig. 1a); wing membrane subhyaline, veins brown; legs brown but distal half of femora and basal one fourth and distal one sixth of tibia dark brown, tarsi dark brown (Fig. 2d).

Terminalia. The posterior margin of tergum 7 with quadrate, rounded and elevated process covered with dense sensilla basiconica (Fig. 2a). Tergum 8 with recurved tongue-like process (Figs 2a). Tergum 9 without sensilla basiconica. Hemitergal processes of tergum 10 with enlarged base and beak-like apex (Figs 1b and 2b). Aedeagal tube strongly sclerotized, with a pair of separate ventroapical lobes, in lateral view nipple like and triangular in shape (Figs 1c and 2c). Aedeagal sac short and gradually tapering to apex, forming nearly a right angle with tube; basal part unarmed and plump, median part with a patch of small spines and apex bearing fine spinules (Figs 1c and 2c).

Female. Unknown.

Etymology. The specific epithet refers to the short ventral lobe of aedeagal tube.

Distribution. China (Fujian).

Diagnosis and remarks. *N. brevistyla* belongs to an informal group of species including *N. biprojecta* Du, 2001, *N. duratubulata* Du, 1999, *N. qingyuanensis* Yang & Yang, 1995, *N. yentu* Cao & Bae, 2007 that bear similar terminalia, sclerotized aedeagal tube and short sac, and a pair of separate ventral lobes of aedeagal tube (for comparison, see figs 3–4, 7 in Li et al. 2013, figs 25–13 in Du 1999, figs 75–77 in Stark and Sivec 2008, and Fig. 6). This species shares a pair of short ventral aedeagal lobes with *N. biprojecta* Du, 2001 (fig. 4 in Li et al. 2013), but the lobes of *N. brevistyla* are triangular and stouter, a patch of dorsal armatures occurs at midlength of the sac (Fig. 1c) which is absent in *N. biprojecta*.

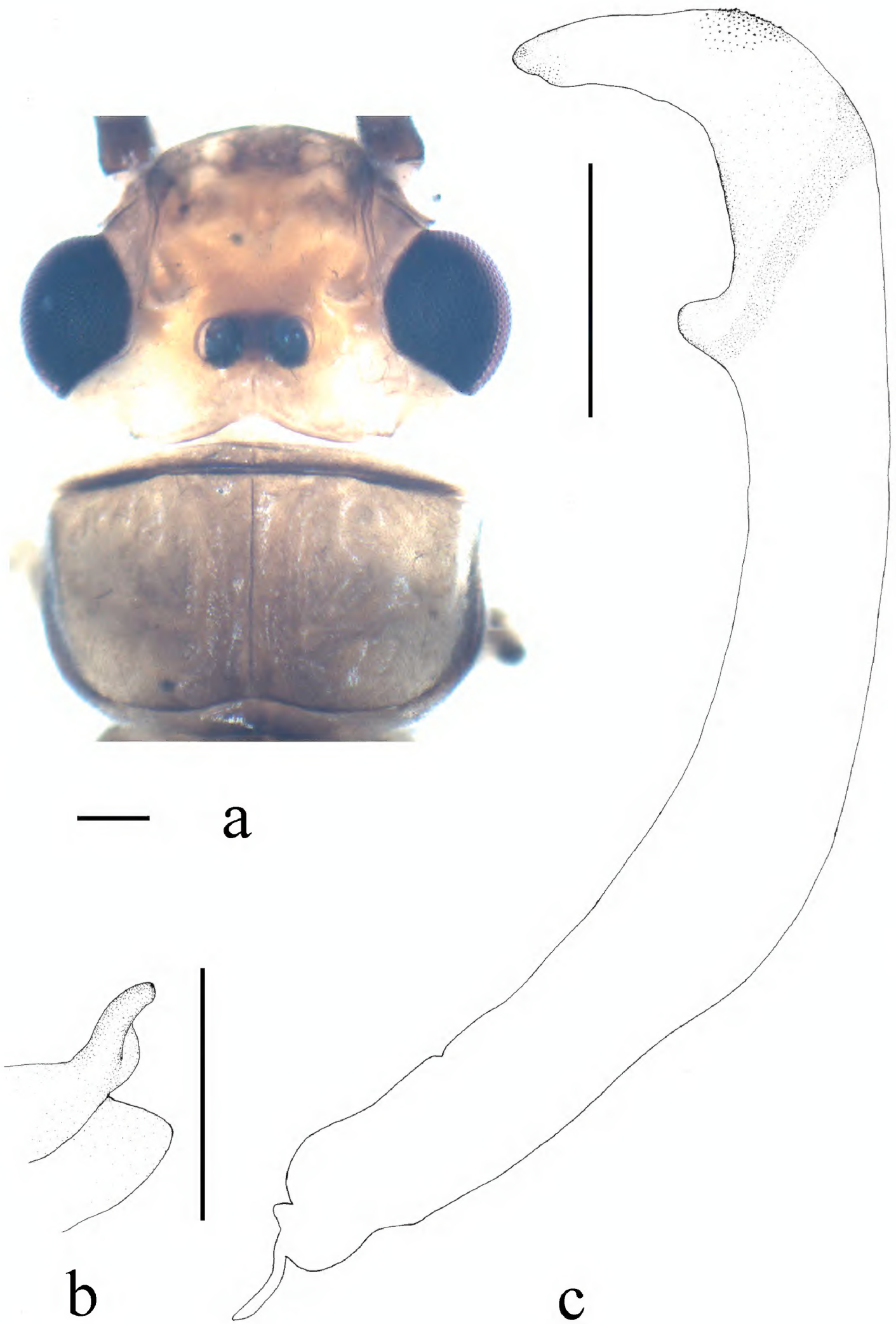

Figure 1. *Neoperla brevistyla* Li & Murányi, sp. n. Male **a** Head and pronotum, dorsal view **b** Hemitergal process, dorsal view **c** Aedeagus, lateral view. Scale bars: 0.5 mm.

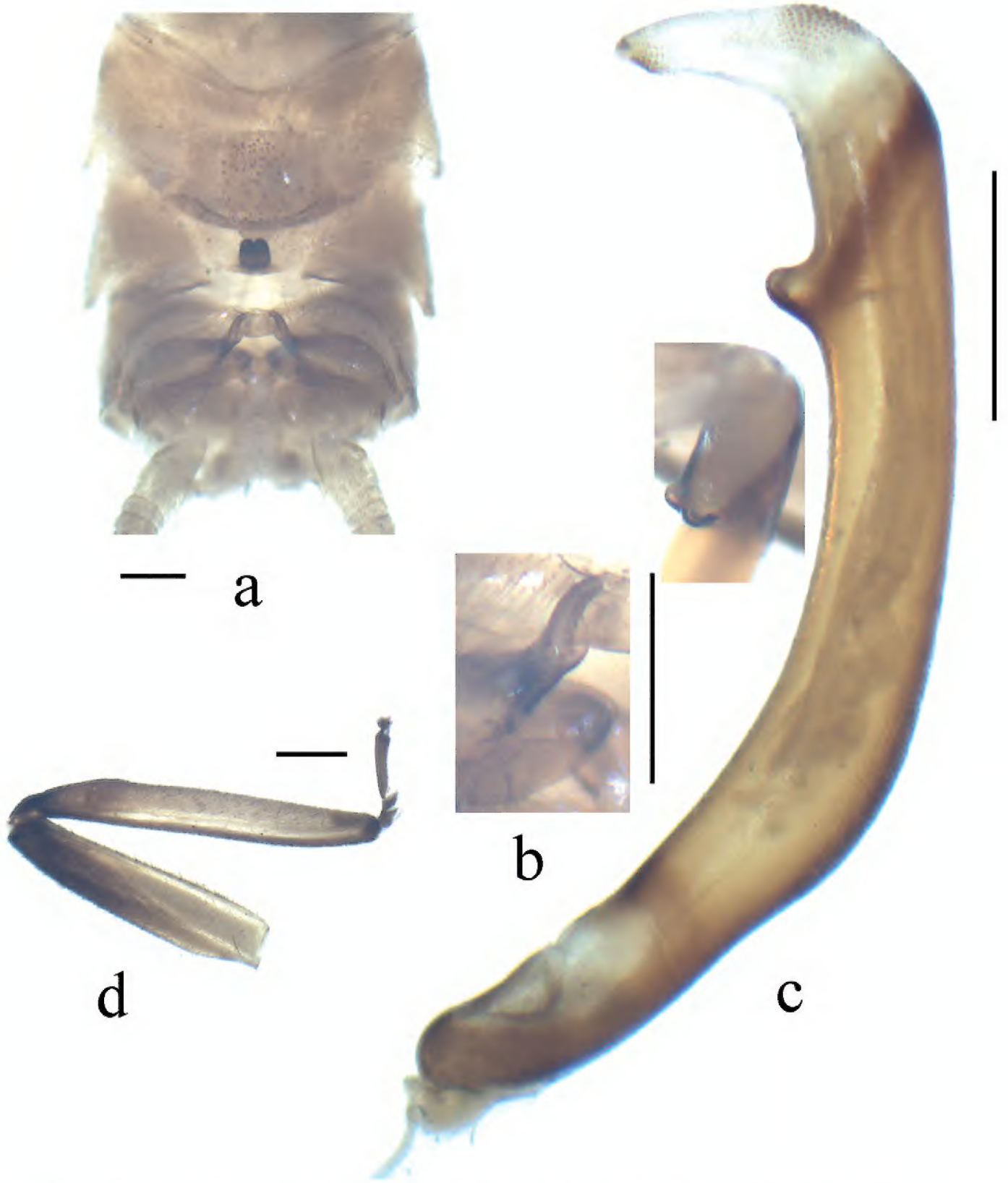

Figure 2. *Neoperla brevistyla* Li & Murányi, sp. n. Male **a** Terminalia, dorsal view **b** Hemitergal process, dorsal view **c** Aedeagus, lateral view **d** Foreleg, lateral view. Scale bars: 0.5 mm.

***Neoperla duratubulata* Du, 1999**
http://species-id.net/wiki/Neoperla_duratubulata

Neoperla duratubulata Du, 1999: 313. Type locality: Fujian Province, Mt. Wuyishan, Sangang.

Remarks. No new material was available for examination. It was stated to be similar to *N. flavescens* Chu, 1929 but bearing paired ventral aedeagal lobes (Du 1999). *N.*

duratubulata may be assigned to the above mentioned subgroup and seems similar to *N. qingyuanensis*. The aedeagal sac of *N. duratubulata* is a very short conical structure with several rows of subapical fine spinules and the head lacks distinct color pattern (modified from the original descriptions of Du 1999).

Neoperla henana Li, Wu & Zhang, 2011

http://species-id.net/wiki/Neoperla_henana
Fig. 3

Neoperla henana Li, Wu & Zhang, 2011: 33. Type locality: Henan Province, Nanyang, Laojieling.

Material examined. 2 males, (CAU), China: Fujian Province, Mt. Wuyishan, Sangang, 27°74.78'N, 117°68.31'E, light trap, 6 Aug. 2006, Hui Dong.

Distribution. China (Fujian and Henan provinces).

Remarks. This species was recently described by Li et al. (2011). The color pattern and terminalia among the types and present material show no variations. The type material (figs 1-3 in Li et al. 2011) seems two teneral specimens where the fine spinules of aedeagal sac are not as well developed as of the present ones (Fig. 3).

Neoperla lii Du, 1999

http://species-id.net/wiki/Neoperla_lii
Figs 4–5

Neoperla lii Du, 1999: 315. Type locality: Fujian Province, Mt. Wuyishan, Sangang.

Material examined. 1 male, (CAU), China: Fujian Province, Mt. Wuyishan, Sangang, 27°74.78'N, 117°68.31'E, light trap, 19 Aug. 2006, Xian Zhou; 4 males, same locality, 25 Sep. 2009, Tingting Zhang, (HIST).

Distribution. China (Fujian).

Remarks. This species was recently described by Du (1999). The original illustrations are rather small in print and show no details on the fine armatures of the sac but the detailed descriptions agree well with the fresh material. We present herein the detailed illustrations of the aedeagal sac for a better diagnosis of *N. lii*.

Neoperla qingyuanensis Yang & Yang, 1995

http://species-id.net/wiki/Neoperla_qingyuanensis
Fig. 6

Neoperla qinyuanensis Yang & Yang, 1995b: 59; Li et al. 2013: 361. Type locality: Zhejiang Province, Qingyuan County, Mt. Baishanzu, Chameiyu.

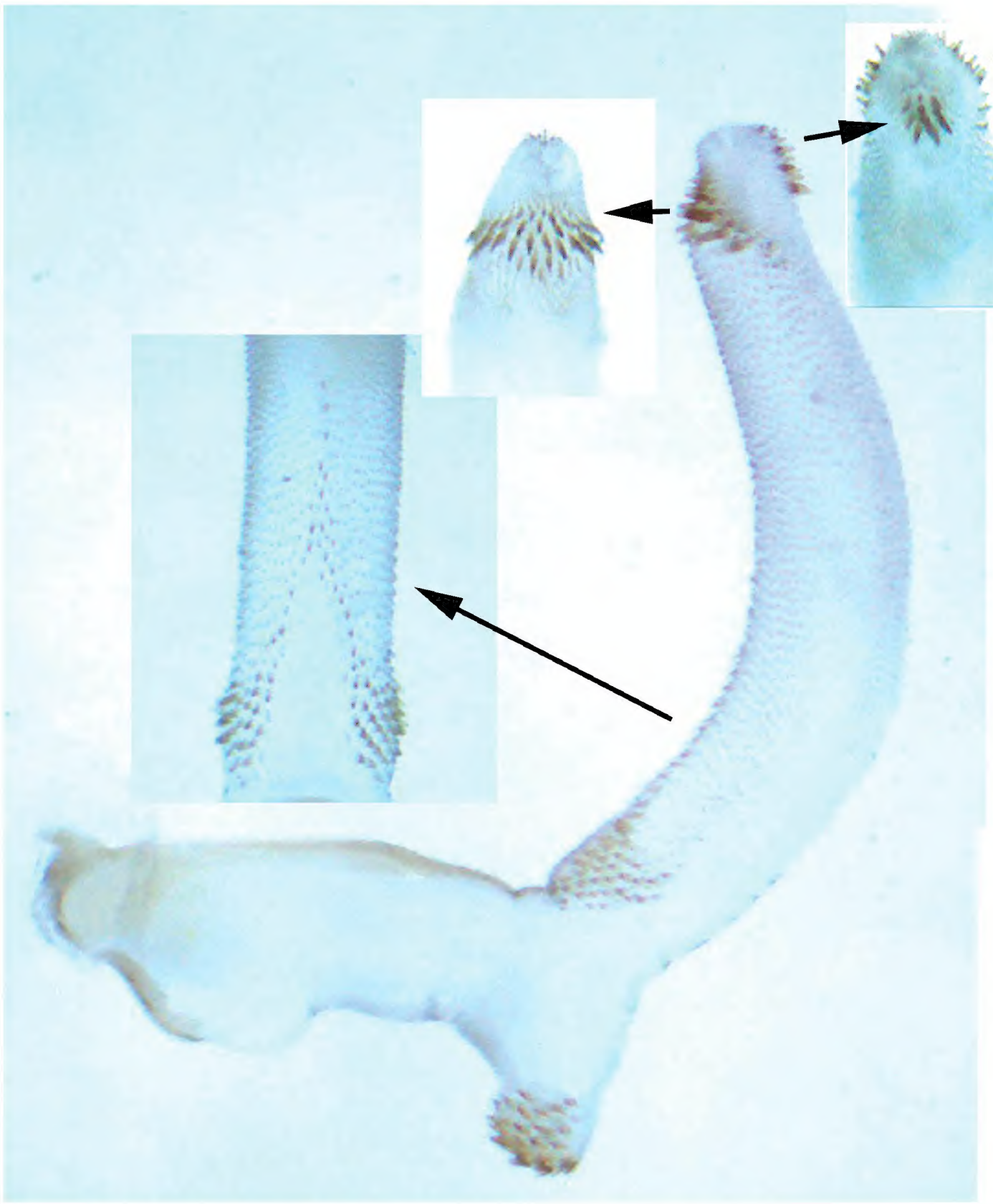

Figure 3. *Neoperla henana.* Male aedeagus, lateral view. Scale bar: 0.5 mm.

Material examined. 2 males, (CAU), China: Fujian Province, Mt. Wuyishan, Sangang, 27°74.78'N, 117°68.31'E, light trap, 6 Aug. 2006, Hui Dong; 1 male, same locality, 19 Aug. 2006. Xian Zhou.

Distribution. China (Zhejiang, Fujian).

Remarks. This species was recently redescribed by Li et al. (2013).The head patterns of the examined types were faded. The illustrations of head pattern and fully extruded aedeagus are provided here on the fresh material to facilitate the identifying of *N. qinyuanensis.*

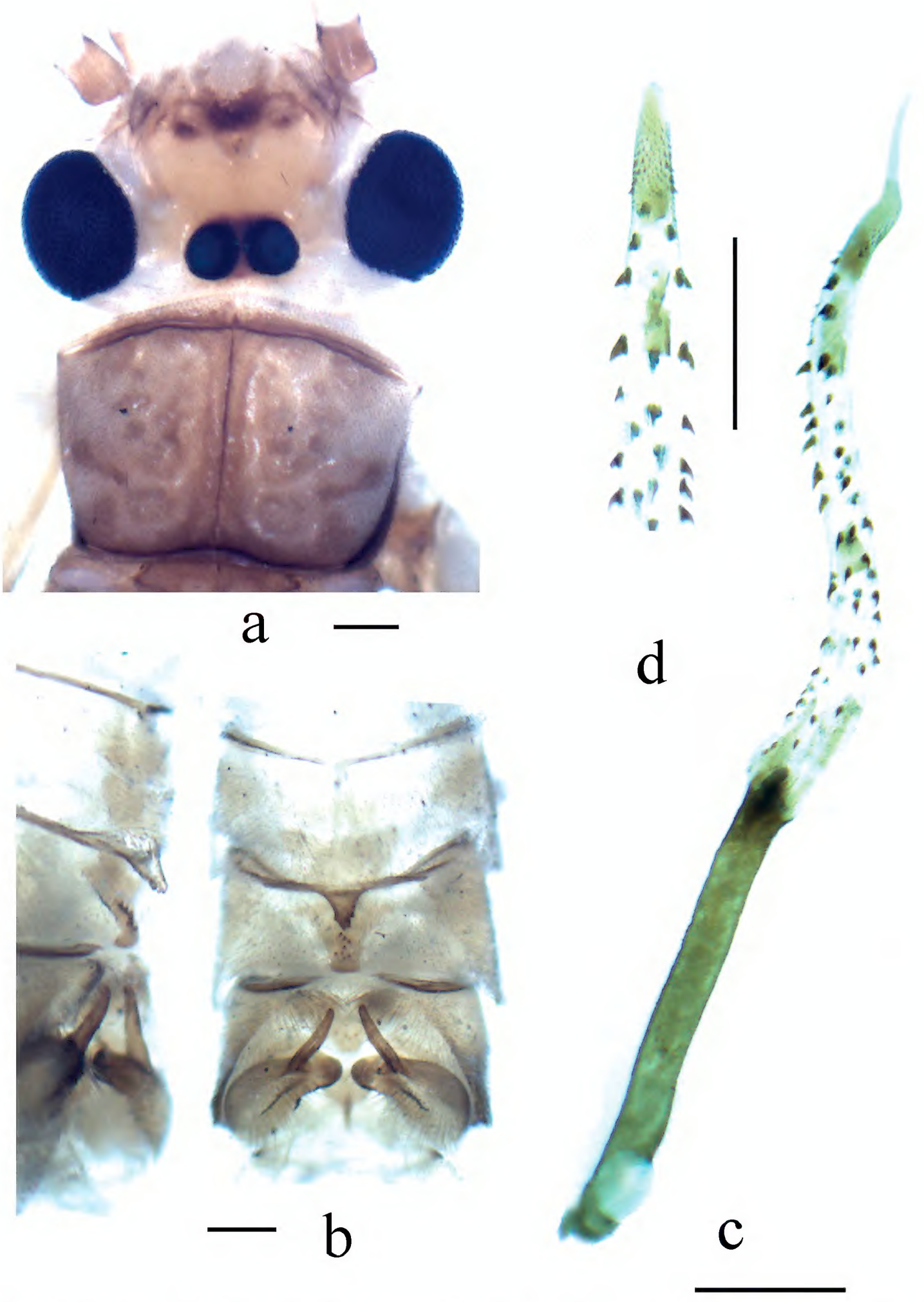

Figure 4. *Neoperla lii* . Male **a** Head and pronotum, dorsal view **b** Terminalia, dorsal view **c** Aedeagus, lateral view **d** Distal half of aedeagal sac, ventral view. Scale bars: 0.5 mm.

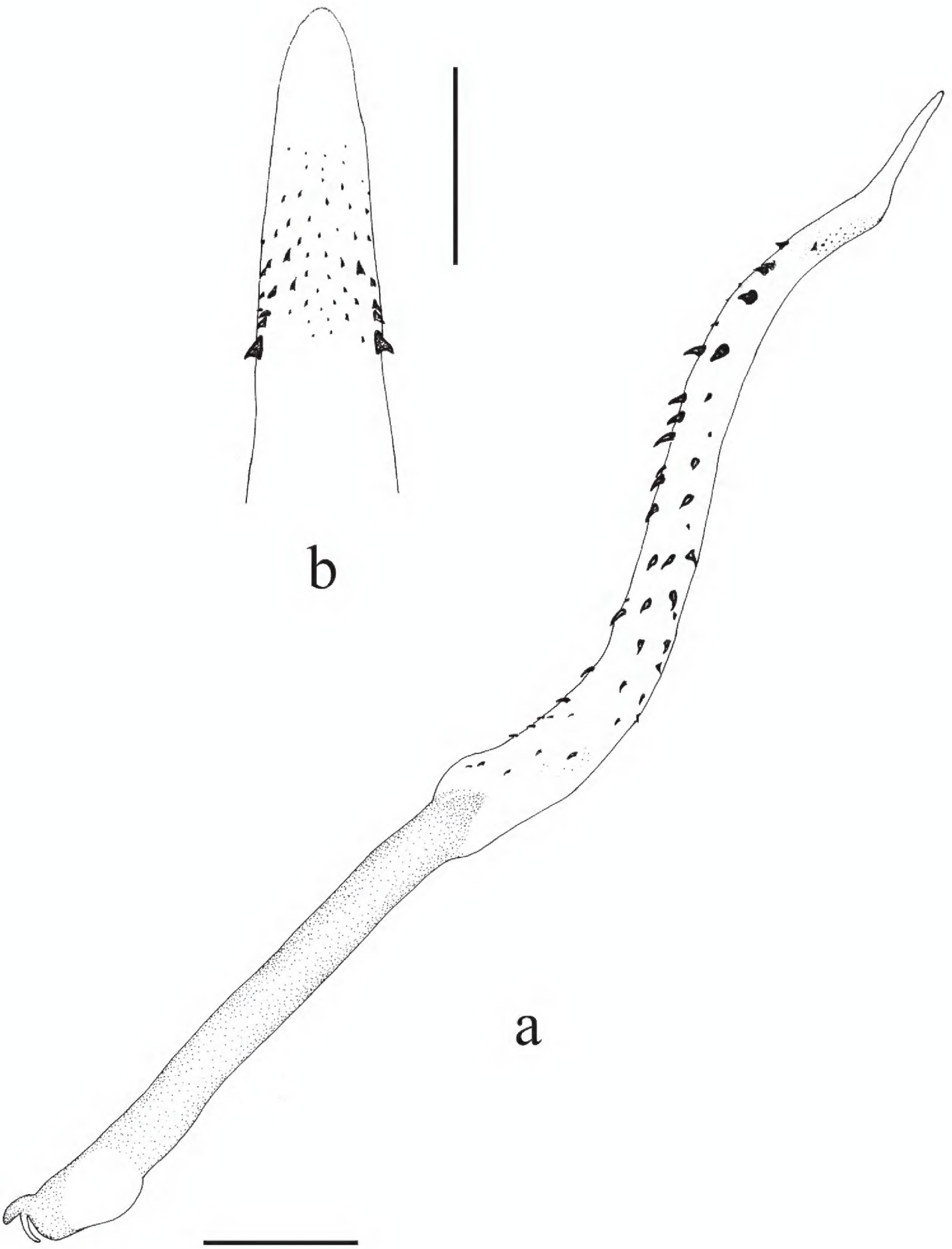

Figure 5. *Neoperla lii*. Male **a** Aedeagus, lateral view **b** Apex of aedeagal sac, ventral view. Scale bars: 0.5 mm.

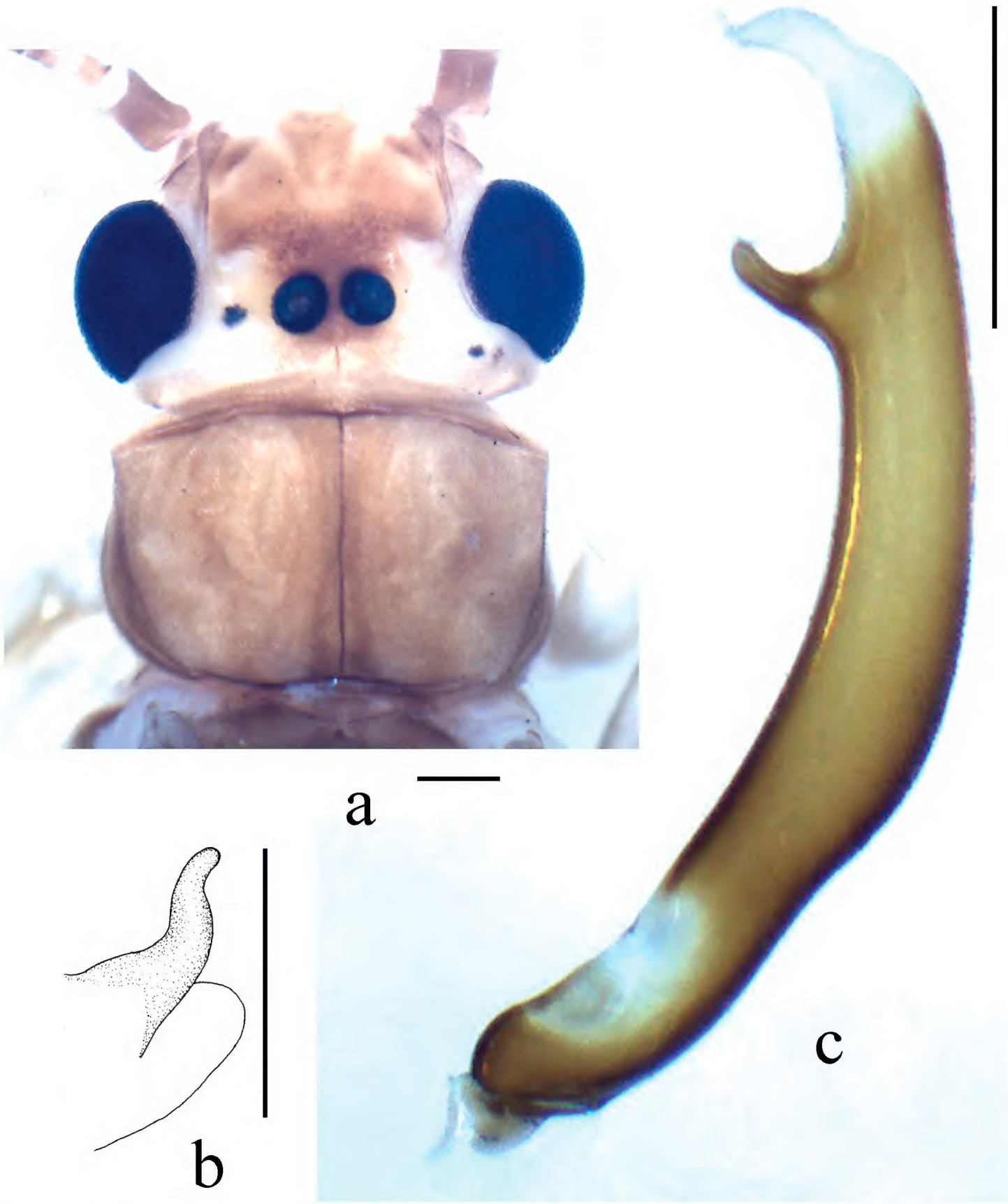

Figure 6. *Neoperla qingyuanensis*. Male **a** Head and pronotum, dorsal view **b** Hemitergal process, dorsal view **c** Aedeagus, lateral view. Scale bars: 0.5 mm.

***Neoperla tuberculata* Wu, 1938**
http://species-id.net/wiki/Neoperla_tuberculata
Fig. 7

Neoperla tuberculata Wu, 1938: 122; Du et al. 2001: 77. Type locality: Zhejiang Province, Mt. Tianmushan.

Material examined. 4 males, (CAU), China: Fujian Province, Mt. Wuyishan, Sangang, 27°74.78'N, 117°68.31'E, 9 May 2004, Xingyue Liu.

Remarks. Our specimens bear slight variation in the aedeagal sac armatures (Fig. 7): the subapical cluster of larger spines in Zhejiang specimens are not prominent in these ones; but they agree well with the Zhejiang one in terminalia features, the head and leg patterns.

Neoperla similidella Li & Wang, 2013

http://species-id.net/wiki/Neoperla_similidella\according to Qin et al 2013

Neoperla similidella Li & Wang, 2013: 25. Type locality: China: Fujian Province, Mt. Wuyishan, Kekao Station.

Additional material examined. 3 males, (CAU), China: Fujian Province, Mt. Wuyishan, Sangang, 27°74.78'N, 117°68.31'E, light trap, 27 Jun. 2009, Li Shi and Xiaoyan Liu.

Distribution. China (Fujian Province).

Remarks. This species was recently recognized by Li et al. (2013) from Wuyi Mountain.

Neoperla similiserecta Wang & Li, 2012

http://species-id.net/wiki/Neoperla_similiserecta

Neoperla similiserecta Wang & Li, 2012: 18. Type locality: China: Guangdong Province, Xinfeng County, Mt. Yunjishan.

Material examined. 2 males, (CAU), China: Fujian Province, Mt. Wuyishan, Sangang, 27°74.78'N, 117°68.31'E, light trap, 12 Jul. 2009, Shi Li and Liu Xiao-Yan.

Distribution. China (Fujian and Guangdong provinces).

Remarks. This species was recently described from Guangdong by Li et al. (2012). The present specimens agree well with the type material.

Neoperla xuansongae Li & Li, 2013

http://species-id.net/wiki/Neoperla_xuansongae

Fig. 8

Neoperla xuansongae Li & Li, 2013: 362. Type locality: Zhejiang Province, Li'an County, Mt. Tianmushan, Sanmuping.

Material examined. 4 males, (CAU), China: Fujian Province, Mt. Wuyishan, Sangang, 27.7478'N, 117.6831'E, 16 Aug. 2006, Hui Dong.

Distribution. China (Fujian and Zhejiang provinces).

Figure 7. *Neoperla tuberculata.* Male aedeagus, lateral view. Scale bars: 0.5 mm.

Remarks. One of the present fresh specimens of *N. xuansongae* shows a heavier head pattern than types (Fig. 8a), and a small mesodorsal patch of spines at base of the aedeagal sac is also present in types but was overlooked in the original descriptions (Fig. 8c).

Provisional key to *Neoperla* species (males) from Wuyi Moutain, Fujian Province, China

1	Aedeagal tube completely sclerotized (Figs 2c, 4c & 6c)	**2**
–	Aedeagal tube incompletely sclerotized (Figs 3, 7 & 8)	7
2	Aedeagal tube with ventral lobes (Figs 1 & 6c)	**3**

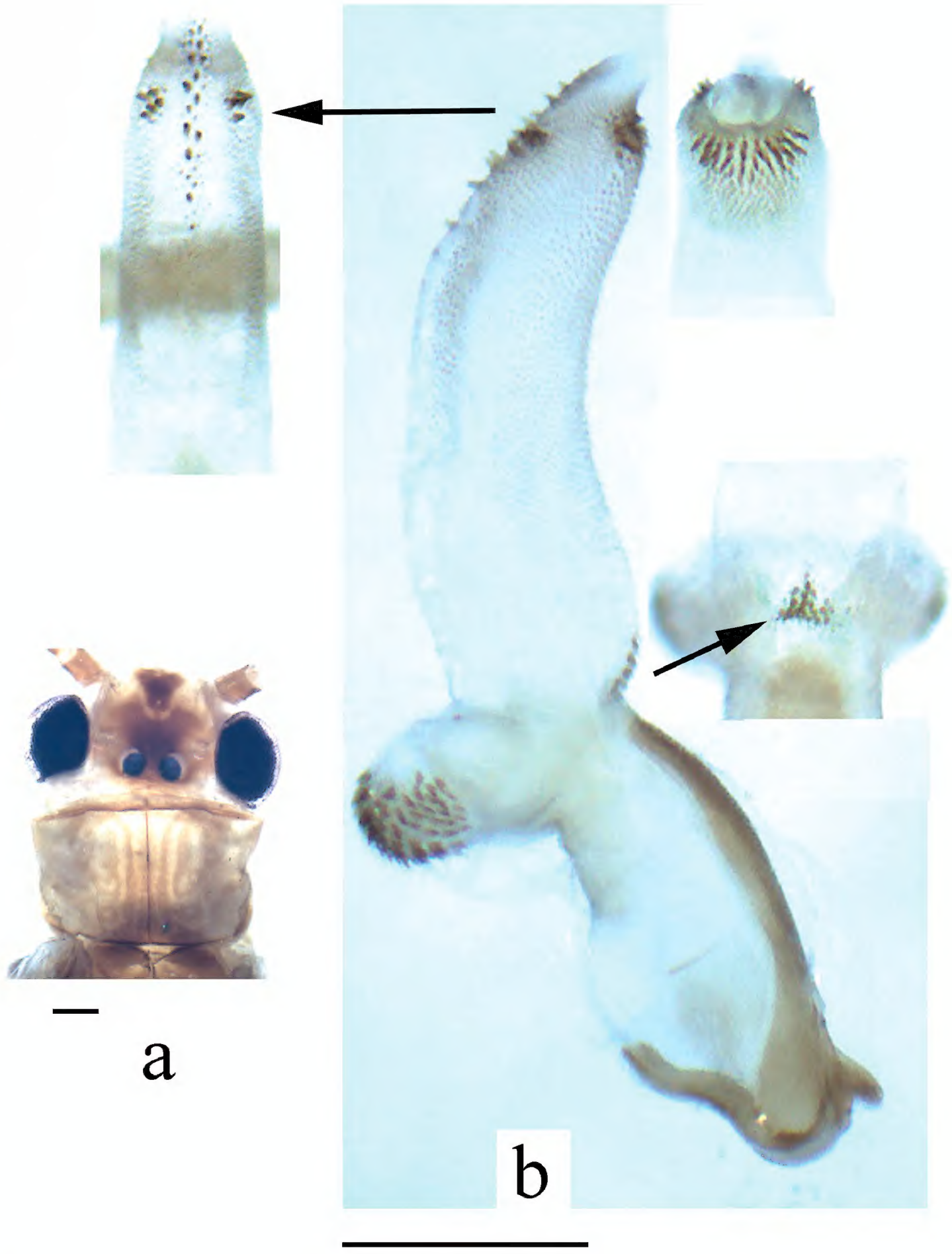

Figure 8. *Neoperla xuansongae.* Male **a** Head and pronotum, dorsal view **b** Aedeagus, lateral view with details in dorsal and ventral views. Scale bars: 0.5 mm.

–	Aedeagal tube without ventral lobes (Fig. 4c)	**5**
3	Aedeagal tube with slender and finger like ventral lobes	**4**
–	Aedeagal tube with nipple like and stout lobes (Fig. 1)	***N. brevistyla* sp. n.**

4 Aedeagal sac a short cone with blunt tip, head without distinct pattern (figs 25–13 in Du 1999) ..... ***N. duratubulata***
– Aedeagal sac with a median constrict and tapering apex, head with distinct median dark brown pattern (Fig. 6) ..... ***N. qingyuanensis***
5 Posterior process of tergum 7 triangular **6**
– Posterior process of tergum 7 quadrate ..... ***N. similidella***
6 Aedeagal sac shorter than tube, covered with spinules (figs 25–12 in Du 1999) ..... ***N. breviscrotata***
– Aedeagal sac longer than tube, covered with many large spines (Figs 4–5, figs 25–16 in Du 1999) ..... ***N. lii***
7 Aedeagal tube with lobes **8**
– Aedeagal tube without lobes (Fig. 7) ..... ***N. tuberculata***
8 Aedeagal tube with an apical lobe (fig. 14 in Li et al. 2012) ..... ***N. similiserecta***
– Aedeagal tube without an apical lobe **9**
9 Aedeagal sac with three apical patches of ventral spines (figs 8–9 in Li et al. 2013; Fig. 8) ..... ***N. xuansongae***
– Aedeagal sac with only one apical patches of ventral spines (Fig. 3) ..... ***N. henana***

Concluding remarks

This study was at the scale of the Wuyi Moutain Nature Reserve. Du (1999) summarized the stonefly fauna in Fujian Province and described three new *Neoperla* from the Reserve: *N. breviscrotata*, *N. duratubulata* and *N. lii*. In the present study, an additional new species is described and added to stonefly fauna of this area: *Neoperla brevistyla* sp. n. The first records of *Neoperla henana* Li, Wu & Zhang, 2011, *Neoperla similiserecta* Wang & Li, 2012, *Neoperla qingyuanensis* Yang & Yang, 1995, *Neoperla xuansongae* Li & Li, 2013 and *Neoperla tuberculata* Wu, 1938 are given for the Reserve. The present study showed that *Neoperla* is the most species rich genus with 10 species currently known from the reserve, 6 species added after the work of Du (1999).

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